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Arcnet and NetBios: Low-Cost Communication Combination

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As Fieldbus progress stagnates, Arcnet backers are making a pitch for the Arcnet-NetBios combination for factory communications.

The information age has caused the same extensive changes in the industrial environment as it has in the office. Like offices, factories now need to process enormous amounts of data and generate millions of transactions to control processes on a factory floor. The old solution of a host computer with remote terminal devices cannot handle the volume of information in the time limit that is needed to keep production volumes high and companies competitive. Local area networks (LANs) are now practical to fill the needs that overloaded hosts cannot meet. LANs provide a cost effective, reliable solution for industrial applications.

The basic set of tools—sensors, actuators, and controllers, now contain 80286 and 80386-based computers, SCADA, and control software. The next area of improvement lies in communication between computers, controls, and I/O. This is where Arcnet, and *de facto* standard communication protocols such as NetBios, can help.

Personal Computers and microcomputer-based communication subsystems are readily available to solve the unique information processing requirements for factory automation and process control. Unlike the office, reliable performance and fault tolerance in a harsh physical environment is imperative for meeting production levels. Even the way devices communicate in a factory is different. Instead of occasionally and asynchronously moving bulky files and records, small amounts of information are constantly transferred. Each machine and operator must be kept updated with the current state of the process, be it assembly, batch, or continuous control. The communication system needs to address these concerns.

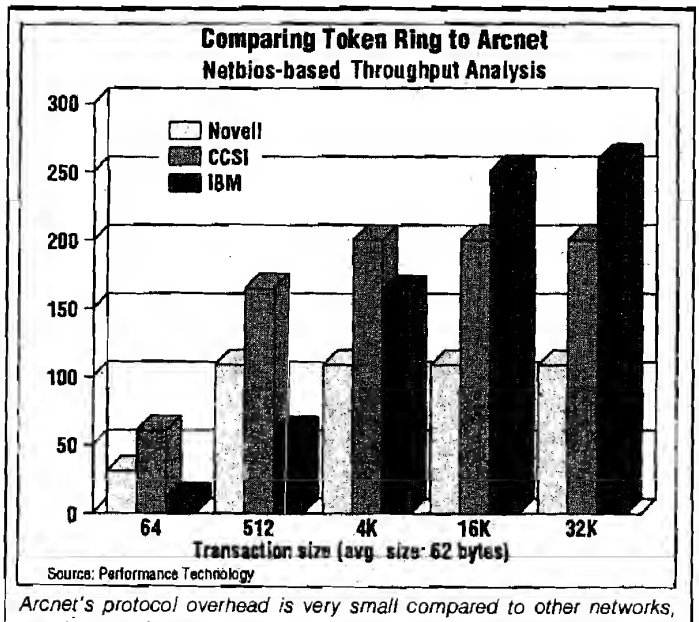
Data processing alternatives

The 4-20 mA current loop has been a very reliable method for transmitting the states of remote units back to a central control system. Each remote sensor had a send and return wire that connected to the control system at the other end. This method transferred data in an analog format that was relatively slow. It has a limited amount of information that can be transmitted due to the 4-20 scale factor. Since speed of a transmission can mean the salvation of a process step or an expensive piece of equipment, it became evident that a faster, more reliable method of transmitting data was required.

The next step in the factory floor's information evolution was the mainframe with remote terminals. This was an improvement over the previous current loop scheme. The communication now moved to a digital format, at a much higher data rate. More information could be transmitted in the same amount of time, more reliably.

But, the mainframe and remote terminals also had their limitations. The mainframe could be overloaded with all of the information from the remote units. It had to process enormous amounts of small messages in a very short time to be effective. As more remote terminals were added to the system, the drain on the central mainframe became even more acute. If the mainframe failed, the entire system could crash, leaving the factory floor without automated intelligence. Having the processing power centralized was clearly not the most effective solution for the factory floor. This alternative still did not meet the fault tolerance, performance, and reliability needs.

In the late 1970s Datapoint Corp. (San Antonio, Tex.) was investigating methods for its computers to share peripherals. Another goal for the Datapoint engineers was to distribute high perfor-



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mance and processing capability in a reliable manner. They developed the Attached Resource Computer NETwork (Arcnet), the first LAN on the scene. Computers are linked to hubs in a star configuration. These hubs can be cascaded in a bus-connection fashion to extend the network. The intelligence for monitoring and controlling processes can be located on-site.

LANs offer reliable, high speed data transmission that can be adapted to a variety of applications. Robotics and their supervisory systems can be adapted to the LAN environment. Before the advent of LANs, robots had to be programmed individually. The LAN allows the programs to be loaded to the robots much faster. This saves time, and also eliminates costly errors that can be caused by human programming.

Arcnet characteristics

Arcnet is the oldest commercially available LAN; it became nonproprietary in 1982. It uses a token passing network access scheme. The node (or computer) that has control of the token (a short message) has the momentary right to transmit its data over the LAN media. The token passes from node to node in a predefined, orderly procedure. Each node on a LAN, especially in factory applications, must be able to acces the LAN media within a specified time. Because of the token-passing routine, the amount of time for each node to receive the token again can be determined. Arcnet is known as being "deterministic." Token Ring is also deterministic.

Arcnet runs with a raw data rate of 2.5M bits per second. This may sound slow when compared to the 10M bits per second of Ethernet 4 or 16M bits per second for Token Ring. In factory applications, millions of small messages of only a few bytes are transmitted. Arcnet was developed to move small messages very quickly and reliably. For most LANs, 90 percent of all messages transmitted are small—only 12 to 20 bytes. Arcnet excels in this transaction processing climate, with its low software overhead. Both Ethernet and Token Ring require large blocks of information to be transmitted with each block of data, this increases the software overhead for these two LAN alternatives, which decreases their effective throughput.

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With an Arcnet LAN, the addition or deletion of nodes is very easy. It is a matter of plugging in or removing a node from an active hub. With the original configurations of Token Ring and Ethernet, the LAN had to be disabled in order to change the number of nodes. Now, both have adopted a hub-type strategy, hubs increase the reliability of the LAN by providing isolation between sections of the LAN. If a hub fails, only those nodes connected directly to that hub will be disabled, not the entire network.

Arcnet is relatively simple to install and maintain. It has a simple protocal which makes its components simpler than the more complex options provided by Ethernet and Token Ring. Of course, with complexity comes expense. Arcnet is more cost effective than either of the other two popular LANs. It is reliable, cost effective, fault tolerant and simple.

Arcnet is a baseband system that does not require a carrier modulated signal such as MAP (Manufacturing Automation Protocol). Being baseband, Arcnet requires less expensive electronics and cabling than MAP.

A real standard for control

The process control industry demands standardization for the method that will be used to transmit digital data in a reliable fashion. In the wake of the ISA SP-50 fieldbus committee's slow progress, Arcnet is becoming even more important. All Arcnet nodes have the same protocol, making it the most "standardized" LAN today. Arcnet boards today will operate with boards that were built 11 years ago.

NetBios for factories

NetBios is the communication standard of choice for networking computers and controllers in the factory. Many control software vendors have a LAN option based on NetBios, so that multiple PCs can share information.

NetBios (NETwork Basic Input/Output Services), is named as such since it is the networking extension to BIOS—that low level set of services inside the personal computer. It gives a common way for computer programs to use LAN interface adaptors, regardless of the brand or kind of network. The engineer now has the freedom to choose the network topology or cabling scheme desired.

NetBios versions are available to cover most of the popular network topologies including Arcnet, Ethernet, and Token Ring. Normally, it is sold as an option to the network adapter card.

Technically speaking, NetBios is a set of functions called by a computer program to provide three basic services: naming and locating nodes on the network (Name Services), sending

Relative LAN Protocol Comparisons

Feature	Arcnet	Token Ring	Ethernet
Overall Cost	Low	High	Medium
Deterministic Scheme	Yes	Yes	No
Software overhead for small packets	Very low	High	High
Token passing access method	Yes	Yes	No
Ease of addition/ deletion of nodes	Easy	Difficult*	Difficult**
Simple protocol	Yes	No	No
Physical topology flexibility (star or bus)	Yes	No*	No**
Ease of installation	Easy	Difficult	Moderate
Minimum packet time	141 microseconds	N/A***	272 microseconds

*New version which uses a MAU (Media Attachment Unit) is a star.

**IEEE 802.3 10BASE-T (twisted pair) is a star.

***The Token Ring media access controller can be accessed only through the NetBios software. Low-level times cannot be isolated from protocol overhead.

short messages across the network (Datagram Services), and maintaining open channels for long computer-to-computer transfers (Session Services). The functions are called the same way no matter what network is used, so network communication code is programmed only once, and it works on any network.

Practically, NetBios is a program one receives (or buys as an option) with a network interface adaptor card. It is run when the computer is first turned on, and remains as part of the machine's BIOS, along with the programs to access the disk or draw on the screen. Now the control software program starts, and uses the communication services of NetBios.

NetBios, created by IBM in 1984, is an early implementation of the Open System Interconnect (OSI) model, the same model from which MAP was derived. NetBios Session services are much like OSI session services. Netbios's Datagram and Name services are analogous to OSI's Network Layer services.

While companies are still lobbying for support of MAP, TOP, and its derivations, NetBios is today successfully controlling processes among multiple vendors' platforms. This has been the basic goal for many years, long before the MAP task force was formed. It is achievable now with NetBios.

NetBios and Arcnet

The NetBios offering we have found to be best suited for factory floor use is Arcnet-NetBios, which is available for DOS, OS/2, VMS (for DEC VAXs), Unix and others. The protocol for these versions is approved by the Arcnet Trade Association (ATA) and certified to be compatible. This means that a network with an application written to run on this large variety of platforms can use NetBios; each machine will communicate with the others.

When passing large files or database records in one big NetBios message, protocol overhead is insignificant. But, when passing large numbers of small messages as is the case in the factory, the overhead becomes critical. Arcnet's protocol overhead is very small compared to other popular networks, and likewise for the ATA's Arcnet-NetBios compared to other versions. Therefore, the combination might be expected to outperform other implementations for short messages (less than 100 bytes or 800 I/O points, for example), but lag behind when doing large file transfers. This is what the results were by independent testers. The combination Arcnet-NetBios is a high-performance communication mechanism for the factory.

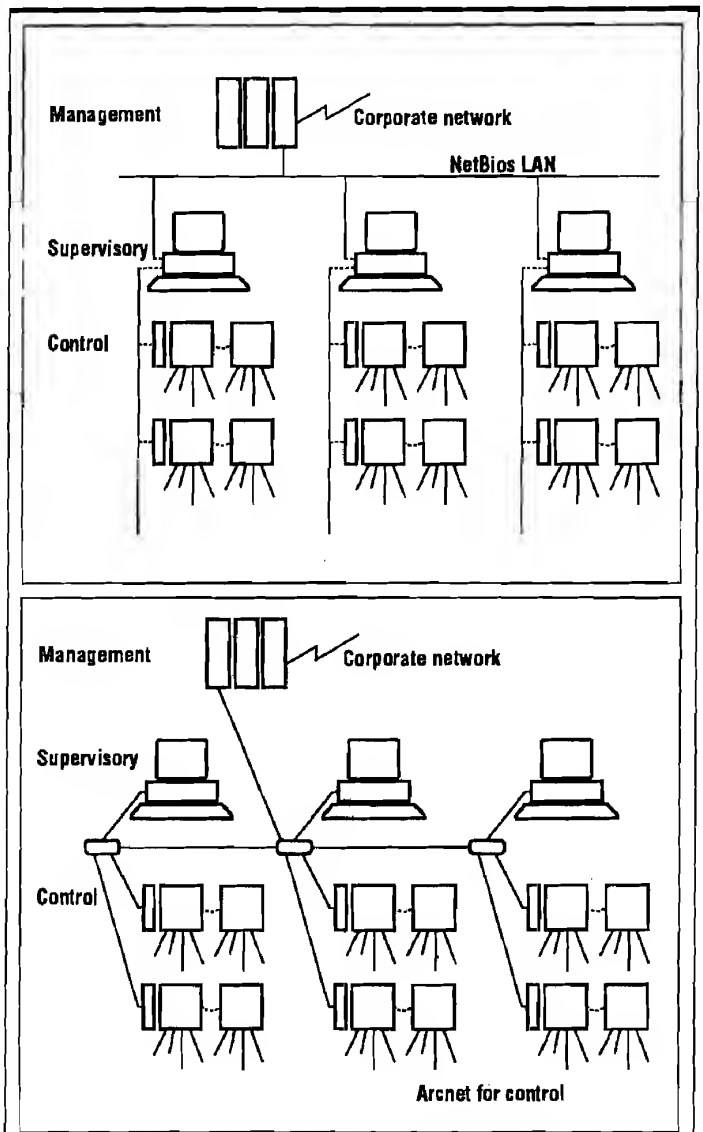
Arcnet-NetBios is very accommodating to factory installation and maintenance personnel. It is available per machine, so one does not have to buy a complete network operating system to connect the machines together. A single Arcnet-NetBios card and disk combination can be ordered for each machine. Arcnet has many cabling options, so the user can take advantage of the economy of twisted pair wiring in clean, conditioned areas, or the noise-immunity of fiber optic cable in electrically noisy areas such as around arc welders, or use coaxial cable, which is the medium of most Arcnet networks.

One should be cautious when buying network equipment so as not to buy more than is really necessary. Novell Netware is the premium file server product with a large installed base. A file server is a dedicated (usually) computer that stores files and programs in a central location for common use. Netware has become synonymous with networking because office automation often requires a file server, and because of its popularity many people specify the Advanced Netware by default. It's best to know that Netware is overkill for a control application that only needs NetBios and no file server.

Alternatively, you can buy an Arcnet-NetBios card and disk for each machine and have a complete communication system. If in the future you need the function of a file server, you can then buy file server software that works on top of NetBios, such as IBM's PC LAN or Performance Technology's Powerlan, or others.

Arcnet and NetBios have bright futures in the industrial environments. Johnson Control is shipping a new environment control system called Metasys, based on Arcnet. Opto 22 is using Arcent for its "mystic" highway. Several other announcements are expected from major vendors who endorse Arcnet as an industrial LAN. Likewise, most of the PC SCADA software packages have committed to NetBios long before MAP as the communication service of choice. Control systems are running today on this combination.

Arcnet and NetBios are a winning combination for the factory environment.□



Top—Factory network today. NetBios LAN connects supervisory control PCs, with PCs tied to control devices through a proprietary cabling scheme. Bottom—Future ARC-control network. With devices adopting Arcnet as their standard, common cabling schemes can be used.

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